



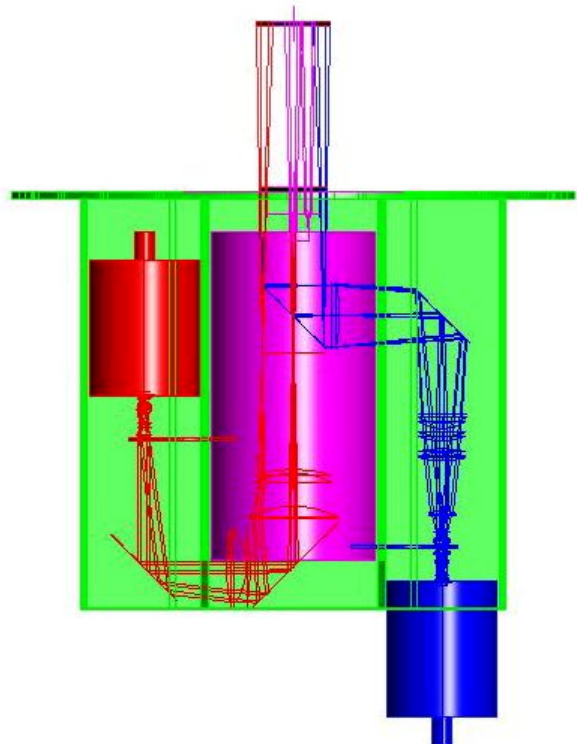
# HOPI:

## A High-Speed Occultation Photometer and Imager for SOFIA

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The CAD drawing to the right shows a top view of HOPI. The large cylinder in the center is a representation of FLITECAM mounted on HOPI. The red and blue HOPI optics and dewars are on the left and the right, respectively. The FLITECAM dewar is above the HOPI optical bench (i.e. out of the page), so the optics in the center of the instrument are actually located beneath FLITECAM. The evacuated region between the instrument flange and the gate valve is shown at the top of the figure, which is the direction toward the telescope.



HOPI is a special-purpose science instrument for SOFIA designed to provide simultaneous high-speed time resolved imaging photometry at two optical wavelengths. It will be possible to mount HOPI and FLITECAM on the SOFIA telescope simultaneously to allow observation at two optical wavelengths and one near-IR wavelength. HOPI will have a flexible optical system and numerous readout modes, allowing many specialized observations to be made. HOPI is also well suited for critical tests of the completed SOFIA Observatory, and will be used for them.

Our main scientific interest is in the use of HOPI for observing stellar occultations. In a stellar occultation, a star serves as a small probe of the atmospheric structure of a solar system object or the surface density structure of a planetary ring or comet. Such observations provide information at high spatial resolution that would otherwise require a space mission to obtain. This work makes use of SOFIA's mobility, freedom from clouds, and near-absence of scintillation noise to provide the best possible occultation data.

## Other Possible HOPI Applications

- Lunar occultations and other spectrally resolved time series observations using a coarse grism
- Detection of P-mode stellar oscillations in sunlike stars
- High S/N multiwavelength lightcurves of transits by extrasolar planets

## HOPI Specifications

- Wavelength Range: 0.30-1.1  $\mu\text{m}$
- CCD Quantum Efficiency: 88% peak,  $\geq 40\%$  from 0.35  $\mu\text{m}$  to 0.85  $\mu\text{m}$ .
- Detectors: EEV CCD47-20 frame transfer silicon CCDs, thinned and backside illuminated, with optimized antireflection coatings  
Format: 1Kx1K with 13 micron square pixels.
- Throughput of HOPI optics:  $\geq 70\%$  from 0.4 to 0.9 microns
- Spectral Resolution: Defined by filters, as narrow as 0.003  $\mu\text{m}$ , with  $\geq 6$  position motorized filter wheels on both channels.
- Number of channels: 2 optical, with 1, 2, or 3 subframes per channel  
Optional simultaneous FLITECAM mount
- Time & 3-D posn accuracy:  $< 1 \mu\text{sec}$  and 30 meters via GPS
- Maximum Frame Rate: 20 ms for three 80x80 pixel subframes per CCD  
10 ms for one 80x80 pixel subframe per CCD  
(in High-speed Series Mode)
- Maximum Time Resolution: 500  $\mu\text{s}$  (continuously with 1-dimensional intensity profile)  
50  $\mu\text{s}$  (in a burst of  $\sim 30$  images)
- Read Noise:  $\leq 6$  electrons max;  $\leq 3$  electrons for slow read
- Field of View on SOFIA: square, 5.6 arcmin on a side, 8 arcmin diagonal.
- Pixel scale on SOFIA: 1.0 "/px (binned) for occultations, 0.33 "/px for testing,  
0.055 "/px with single bare CCD.
- Optical system: 80% enclosed light in 1 unbinned pixel  
Distortion well characterized for chopper testing  
Shack-Hartmann capability in one channel  
Pupil imaging mode and Focault test capability  
Pupil mask with x-y adjustment  
Optional evacuated light path from instrument to gate valve
- Data Format: Simple FITS, 2d or 3d files, one per subframe

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HOPI will be available for Guest Investigator use on a collaborative basis, and potential Guest Investigators should contact the PI prior to proposing to insure that the proposed observations are feasible and make the best use of HOPI's capabilities. For more information on HOPI, please see our abstract at:

**[http://www.sofia.usra.edu/observatory/instruments/first\\_light/ho\\_pi\\_abstract.html](http://www.sofia.usra.edu/observatory/instruments/first_light/ho_pi_abstract.html)**

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